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EFFECTS OF THINKING MAPPS STRATEGY ON JUNIOR SECONDARY TWO STUDENTS' ACHIEVEMENT IN BASIC SCIENCE AND TECHNOLOGY IN JABA, KADUNA STATE, NIGERIA

PETER JOSEPHINE DOGARA
College of Education Gidan Waya Kaduna State, Nigeria
Email: josephinedpeter@gmail.com

&
GRACE AZUMI CHOLLOM (PhD)
Department of Science and Technology Education
Faculty of Education University of Jos, Nigeria
Email: ngocolom@gmail.com

ABSTRACT

This research investigated the effects of thinking maps strategy on JSS II students' achievement in Basic Science and Technology in Jaba Kaduna State, Nigeria. The study adopted a quasi-experimental research design the Population comprise all J S II students in Jaba local government of Kaduna State with a sample of 178 students from two intact classes. 88 students formed the controlled group, while 90 students were exposed to the treatment.. a Two research questions and one hypothesis guided the study. The study was anchored on the Social constructivist theory by Lev Vygotsky. Two instruments were used for data collection namely; Student Achievement Test (BSAT) and Observation of Structural Strategies Scale (OSSS). The validity of the instruments was determined through the scrutiny of two experts science educators and one expert from measurement and Evaluation Unit, all from Faculty of Education, University of Jos. The reliability of the BSAT was determined to be 0.85, and 0.82 for OSSS, using Pearson Product Moment Correlation coefficient. Research questions were answered using mean and standard deviation while the hypothesis was tested using t-test statistics at 0.05 level of significance. The pre-test result revealed that most students score below average in Basic Science and Technology and that the groups were statistically equivalent on the basis of achievement. Post-test result shows great improvement in students' achievement score in Basic Science and Technology in the experimental group. Based on these findings, it was recommended that teachers should use the thinking map approach in teaching Basic Science and Technology to students in Nigerian junior secondary schools.

Keywords: Effects, Thinking Maps, Basic Science, Academic Achievements.

Introduction

Basic Science and Technology began in Nigeria as Integrated Science. The emphasis is that all science subject are integrated and presents them all as unified science concepts through inquiry. With time important societal issues were also in cooperated into the Basic Science and Technology curriculum to enable learners to be aware of such issues and acquire skills for solving the issues. Several reviews made modification on the basic science curriculum reviews such as those of the Science Teachers' Association of Nigeria (STAN) have attempted to integrate all topics regarded as necessary for giving learners the fundamental knowledge

of science and training learners to be architect of their learning through child-centered teaching strategies.

However, studies by Abubakar (2019) revealed that the traditional methods of teaching sciences through un-directional lecture method in Nigerian secondary schools is not effective in meeting the learning needs of students because they lack activity based learning. Jones and Jones (2018) corroborated this point when they observed that the teaching sciences in Nigerian secondary schools is dominated by the lecture teaching strategy which may not be effective in imbibing science knowledge and principles in students because most aspects of science curriculum are activity-based and require manipulation of instructional materials and interaction among peers to learn. According to Ozoji (2018), the lecture method which is used by most science teachers in Nigerian schools, is ineffective, not learner-centered and stifle meaningful learning and understanding of concepts and principles. There is therefore, the need for more activity-based innovative and learner-centered methods of teaching for effective science delivery. Such methods include; questioning-answering method, problem solving method and cooperative learning among others.

It is not surprising that over the past decade, there has been consistent poor academic achievement by students in Basic Science and Technology. The Basic Education Certificate Examinations (BECE) results of students in the area of study show that in the years 2015 to 2016, 53.62% of the candidates who sat for the examinations failed to pass at credit level (2011 in 36%, 39.22% in 2012, 41.13% in 2013, 39.42% in 2014, 54.5% in 2015 and 53.22% in 2016) (Daily Sketch, 2019). The decline in the academic achievement of students is one of the problems that is generating public outcry in Nigeria. The Federal Government of Nigeria in the National Policy on Education (Federal Republic of Nigeria, 2013) stated that the goals of science education in Nigeria should be to produce scientists for national development; and to service studies in technology and the cause of technological development. In further pursuance of these goals, the federal government made concise effort to boost the teaching and learning of science, such as, establishing more universities of technology, organizing workshops and seminars for science teachers, providing science learning facilities in schools, building more science schools at the secondary school level, the implementation of the 'Step B' project, review of science curricular materials and texts through the instrumentality of the Nigerian Educational Development and Research Council (NERDC) and the Science Teachers' Association of Nigeria, respectively. Despite the efforts of government to reposition the teaching and learning of science experience and available literature such as (Wang, 2015; Jones and Jones, 2015) show that students achieve poorly in science subjects at all levels of education (Daily Sketch, 2019). In view of the lapses inherent in the lecture method and the subsequent low achievement by students, researcher in Basic Science and Technology are continually making effort towards improving students' academic achievement in Basic Science and Technology. Studies by Wang (2015) have shown that some strategies such as jigsaw, inquiry-based target method, peer tutoring and thinking maps have the tendencies to improve students' academic achievement in Basic Science and Technology.

Thinking-mapping strategy is one of the major types of cooperative learning strategy which is a useful technique for helping younger students with the process of building conceptual understanding of content and promoting achievement. By using thinking maps instead of traditional lecture methods of teaching, students are able to visualize links between non-linear

ideas, which in turn provide for creativity and meaningful learning. The use of colour is often used to differentiate the ideas contained within the thinking map, which enhanced the utility and meaningfulness of the maps to learners who construct them (Mona & Khalick, 2018). Thinking maps are essentially the visual representation of students' thought, as such, they allow for a greater retention of information by students.

One of the most important aspects of thinking maps is the ability of students to display critical thinking skills in the course of completing their maps. Savich (2019) noted that the focus on critical and independent thinking were effective ways for teachers to maximize the engagement of students in his class (Savich, 2019). Specifically, Savich utilized role-playing and simulations to convey material to the students – a process which required all students to be engaged in a more critical manner of thinking. Savich concluded that his inquiry method of teaching allowed even the least confident students in his class to feel connected to the material, which in turn allowed them to see the bigger picture of history (Savich, 2019).

Numerous factors have been attributed to the poor achievement in Basic Science and Technology in Nigeria. These include inadequate use of instructional materials, lack of qualified and experienced science teachers, poor students' motivation and the most common being the use of poor instructional strategies (Wang, 2015). The instructional strategy that a teacher adopts in the classroom has direct effects on achievement of the students. In view of the visible loop holes in the conventional strategy in Basic Science and Technology classrooms, and the obvious abysmal achievement by students, there is need for a paradigm shift from the old conventional method to better cooperative teaching strategy. It is in the light of the above that this study was prompted to investigate the effects of thinking map strategy on student's academic achievement in Basic Science and Technology in Jaba Local Government Area of Kaduna State.

Thinking Maps are a set of graphic organisers techniques used in primary and secondary education. There are eight diagram types that are intended to correspond with eight different fundamental thinking processes (Ezeudu, 2015). They are supposed to provide a common visual language to information structure, often employed when students take notes. Thinking Maps are visual tools for learning, and include eight visual patterns each linked to a specific cognitive process (James, 2019). Thinking maps are graphic representation often used in education for analyzing researching organizing and learning (Clark and Paivio, 2016), they are meaningful in showing association and understanding or misunderstandings and to acquire basic knowledge and develop higher order thinking skills (Mcmacking & Witherel, 2015). Teachers may apply Thinking Maps in all content areas and all grade levels. The eight map types include circle maps, used for defining in context, bubble maps; used for describing with adjectives, flow maps; used for sequencing and ordering events, brace maps; used for identifying part/whole relationships, tree maps; used for classifying or grouping, double bubble map; used for comparing and contrasting, multi-flow map; and used for analyzing causes and effects and bridge map; used for illustrating analogies (Ezeudu, 2015).

According to Okebukola (2017), by linking each thinking skill to a unique and dynamic visual representation, the language of Thinking Maps becomes a tool set for supporting effective instructional practice and improving student performance. Teachers and students, therefore, independently apply thinking skills for their own learning while also having a common visual

language for cooperative learning. By having a rich language of visual maps based on thinking processes, learners are no longer confused by poorly organized brainstorming webs or an endless array of static graphic organizers. They are enabled to move from concrete to abstract concepts, think with depth, and directly apply their thinking to complex tasks (Busari, 2016).

Basic Science and Technology principles are intended to produce among other things, a course which, is relevant students' needs and experiences, stresses the fundamental unity of science, lack of adequate foundation of subsequent specialized studies and adds a cultural dimension to science education. Danlami (2015) noted that the objective of Basic Science and Technology was based on the desire to teach conceptual thinking coupled with manipulative skills. It is therefore a concept oriented curriculum. One of the aims of this conceptual approach is in getting at the essential structure through the use of central theme which will permit the instructional materials when presenting the supported matter.

Research into the general effectiveness of thinking maps through pretest-posttest research designs, suggests that thinking map is superior to traditional learning in terms of academic achievement (Acar & Tarhan, 2018) and social development (Ebrahim, 2015). Thinking map has positive effects on learning mathematical concepts (Hooker, 2016). Artut (2019) concluded that, the thinking map lesson plans used in the program allowed the children to develop both their mental and motor skills as they incorporated literature, art, and mathematics at the same time.

Technology according to some researchers has the great potentials to help the development of thinking map outcomes for students (Mevarech, 2015). The challenges of teaching science are to teach it in a way that enables pupils to learn science concepts while acquiring process skills and positive scientific attitudes. One of the effective ways of accomplishing these objectives is through involving students in hands-on activities in the context of thinking map. Brad (2015) investigated the effectiveness of thinking map on students' academic performance in computer under cooperative and teacher-centered learning environments. He found that students in thinking map group exhibited higher level of academic performance.

The results of several studies show that thinking map has positive impact on students' academic achievement. Chien (2017) conducted an experiment on two vocational senior high classes to observe thinking map effect in the EFL classroom. Result indicated that students in cooperative EFL learning group performed better than their colleagues in the traditional EFL learning group. Chien's (2017) study was in agreement to her study in 2002. She created a measurement to gauge the effectiveness of thinking map. Her results showed that students in thinking map group improved in their posttest scores over time, which indicated that thinking map could improve English skills. How thinking map affects student's achievement and problem solving skills was investigated by Effandi in 2003. This study of intact groups compared students' mathematics achievement and problem solving skills. The experimental group was instructed using thinking map methods, while the control section was instructed using the traditional lecture method. Results indicated that students in cooperative group instruction showed significantly better results in mathematics achievement and problem solving skills than their colleagues in the traditional group.

Similarly, Leman (2017) examined the effect of thinking map on ninth grade students' understanding of metallic bonding, the results of the students' t-test indicated that the mean score of the students in thinking map group was significantly higher than the mean score of their colleagues in control group. In fostering student learning outcomes, not all the studies on thinking map recommended the effective use of thinking map methods. Ghaith and Abd El-Malak (2018) examined the effect of cooperative Jigsaw II strategy on improving literal and higher order reading comprehension in English as a foreign language (EFL). The researcher employed a pretest-posttest control group experimental design. The results indicated no statistically significant differences between the students in the Jigsaw group and traditional competitive group on the dependent variables of overall reading comprehension and literal comprehension.

Statement of the Problem

Over the years, there has been a general decline in students' achievement in Basic Science and Technology. A lot of students in Nigerian junior secondary schools seem to exhibit unserious attitudes towards learning Basic Science and Technology and this has contributed to their poor learning in the subject. It is disheartening that a subject of great importance to human development such as Basic Science and Technology should be marked with such poor attitudes and achievement. The Basic Education Certificate Examinations (BECE) results of students in Kaduna States how that in the years 2011 to 2016, 53.62% of the candidates who sat for the examinations failed to pass at credit level (2011 in 36%, 39.22% in 2012, 41.13% in 2013, 39.42% in 2014, 54.5% in 2015 and 53.22% in 2016). This implies that only 46.38% of the candidate passed the examinations at credit level and above.

Many researchers and scholars such as Larry and Hartman (2015), Ozoji (2018) and James (2019) blamed this sordid situation on the teaching method and competence of teachers. The teaching of Basic Science and Technology is dominated by the traditional lecture method which has proven ineffective over the years. The problem of this study therefore lies in ascertaining the effects of thinking map strategy on student's academic achievement in Basic Science and Technology in Jaba Local Government Area of Kaduna State.

Research Questions

The following research questions guided the study:

1. What is the difference in the pre-test achievement scores of the students in the experimental and control groups?
2. What is the difference in the post-test achievement scores of the students in the experimental and control groups?

Hypotheses

The null hypothesis was tested at 0.05 level of significance:
Ho1: There is no significant difference between the post-test achievement mean scores of JSS II students exposed to thinking map strategy and those not exposed.

Methodology

This research investigated the effects of thinking maps strategy on JSS II student's academic achievement in Basic Science and Technology in Jaba Local Government Area of Kaduna State. Quasi-experimental design was employed comprising of two intact un equivalent

classes were used as experimental and control groups respectively The study adopted the purposive sampling technique to select two schools with comparable characteristics from the study area. Purposive sampling is appropriate because the researcher has previous knowledge of the population and has specific purpose as judge for the selection of the two schools for the study. The instrument used for data collection was the Basic Science and Technology Achievement Test (BSTAT). The content validity of the instrument was ascertained two expert in Science Education, Faculty of the Faculty of Education and University of Jos. The test –retest method was used to determine the reliability of the BSTAT. In this case, the same test was administered to students within an interval of two week during trial-testing and then, the two sets of results was correlated to obtain the coefficient of stability, the Pearson- Product moment correlations was used for the correlation. The reliability coefficient of the BSTAT was 0.85. All the research questions formulated in this study were answered using means standard deviations while the hypothesis was tested using t-test statistics at 0.05 level of significance.

The Training Model

Thinking Maps is a set of graphic organizer techniques which are used teaching the concepts of photosynthesis and respiration to the students. Students were exposed and drill on how to use different thinking maps to form links between on concept to the other. For example, using circle thinking maps to brainstorm and show how process of photosynthesis starts from the sun to the plants, use of a flow thinking maps to show link between carbon dioxide and food manufacturing process of photosynthesis, use of bubble maps to assist in defining quantities, Multiple flow map show the directions of causes and effects of respiration on absorbed food particle using oxygen in the air that we breathe in to produce carbon (iv) oxide, water vapour and energy, the use of tree thinking maps to classify the types of respiration and many other activities involving the different thinking maps. Learners were exposed to eight diagram types that correspond with eight different fundamental thinking processes which provide a common visual language to information structure. By using thinking maps instead of traditional lecture methods of teaching, students are able to visualize links between non-linear ideas, which in turn provide for creativity and meaningful learning. The use of colour was often used to differentiate the ideas contained within the thinking map, which enhanced the utility and meaningfulness of the maps to learners who construct them. Evaluation was conducted to ensure that students master the used of thinking maps in learning science concepts.

RESULTS AND DISCUSSION

Research Question One

What is the difference in the pre-test achievement scores of the students in the experimental and control groups?

Table 1: Basic Science and Technology Achievement Test Pre-test Mean Scores of Experimental Group

Group	N	$\bar{X}$	SD	$\bar{X}$-diff
Experimental	90	40.27	6.28	0.54
Control	88	39.73	10.37	

Table 6 shows that the BSTAT pre-test mean scores of the experimental and control groups were 40.27 and 39.73respectively. The mean difference was 0.54 which implies that there was no significant statistical mean difference in the BSTAT achievement of students in the experimental and control before exposure to treatment.

Research Question Two
What is the difference in the post-test achievement scores of the students in the experimental and control groups?

Table 2: Basic Science and Technology Achievement Test Post-test Mean Scores of Experimental Group

Group	N	$\bar{X}$	SD	$\bar{X}$-diff
Experimental	90	69.18	7.91	26.88
Control	88	42.30	9.36	

Table 2 shows that the BSTAT post-test mean scores of the experimental and control groups were 69.18 and 42.30 respectively. These results indicate that thinking maps strategy of instruction led to an improvement in students achievement score in Basic Science and Technology Achievement Test with a mean difference of 26.88.

Hypothesis One: There is no significant difference between the pre-test and post-test Basic Science Achievement Test mean scores of students in the experimental group.

Table 3: Summary of t - test Analysis of Pre-test and Post-test Basic Science Achievement Test Mean Scores of Experimental Groups

Test	N	$\bar{X}$	SD	Df	p.value	Sig. Level
Pre-test	90	40.27	6.28	178	0.97	0.05
Post-test	90	69.18	7.91			

$P \geq 0.05$

Data on Table 3 shows that the p-value of 0.97 was greater than the significant level of 0.05. The null hypothesis was therefore rejected. The conclusion is that there was a significant difference between the pre-test and post-test Basic Science and Technology achievement mean score of students in the experimental group.

Discussion
The results of the study showed that thinking mapping strategy led to an improvement in students' achievement in Basic science and technology.

Table 1 shows that the BSTAT post-test mean scores of the experimental and control groups were 69.18 and 42.30 respectively. This resulted indicate that thinking maps strategy of instruction led to an improvement in students achievement score in Basic Science and Technology Achievement Test with a mean difference of 26.88. This is in line with the view

of Opara (2010) who found that thinking mapping teaching has a significant impact in improving students' achievement in mathematics

Table 2 shows that the BSTAT post-test mean scores of the experimental and control groups were 69.18 and 42.30 respectively. This results indicate that thinking maps strategy of instruction led to an improvement in students achievement score in Basic Science and Technology Achievement Test with a mean difference of 26.88. This finding is in consonance the finding of Nwagbo (2019) who discovered a significant impact of guided inquiry and thinking mapping strategy on students' academic achievement in Basic Science and technology.

Data on table 3 shows that the p-value of 0.97 was greater than the significant level of 0.05. The null hypothesis was therefore rejected. The conclusion is that there was a significant difference between the pre-test and post-test Basic Science and Technology achievement mean score of students in the experimental group. This finding corroborates the findings of Giwa and Ilo (2000) who discovered that thinking map strategy improves students' academic achievement in mathematics.

Conclusion

This study which investigated the effects of thinking maps on students' achievement in Basic Science and Technology has revealed that thinking mapping strategy had a significant effect on JSS II students' achievement in Basic Science Achievement Test. It was concluded that the use of thinking mapping strategy in teaching Basic science and technology can be a strategy for enhancing students' achievement in the subject.

Recommendations

The following recommendations were made in the light of the findings of the study:

1. Teachers should use the thinking mapping strategy in teaching science concepts in junior and senior secondary schools in Nigeria.
2. Teachers should be given adequate training on the use of thinking maps instruction through workshops and conferences mounted by the ministries of education and professional associations such as the Science Teachers' Association of Nigeria.
3. Curriculum designers and textbook writers should incorporate thinking mapping activities in the basic science and other curricular and texts.

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